The Prognostic Value of Preoperative Evaluation of Patients Undergoing Thoracic Surgery

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INTRODUCTION

EMPHYSEMA, CARDIAC DISEASE, advancing years—these are among the many factors often complicating the clinical picture of the patient with lung cancer being considered for thoracic surgery. Evaluation of these patients, in addition to thorough history, physical examination, and appropriate laboratory, electrocardiographic and roentgen studies, usually includes assessment of pulmonary function, both by clinical observations and by mechanical measurements. Despite thoughtful attention to all these elements, physicians are frequently troubled by a patient failing to survive thoracic surgery, or becoming a respiratory cripple.

In an attempt to see if definite criteria might be found indicating whether or not such surgery would be tolerated, the experience at Memorial Hospital has been reviewed. The value of pulmonary function tests has been discussed by many authors, but these studies usually have been of patients without malignant disease. It was felt to be of interest to examine the experience involving neoplastic disease, where pulmonary resection was the treatment of choice, and every effort was made to bring the patient to, and through, surgery.

MATERIALS AND METHODS

The charts of all patients at Memorial Hospital from 1949 through 1960, both private and ward, having thoracic surgery preceded by complete clinical evaluation, including pulmonary function tests, were reviewed. The only charts excluded were those having inadequate follow up.

History and physical examination described by the resident house staff, and attending physician, were examined particularly for the presence or absence of the following: exertional dyspnea, chest pain, cough, smoking habits, hypertension, low hemidiaphragm and/or increased anteroposterior diameter of the chest, wheezes, râles, cardiomegaly, and a prominent pulmonary second sound.

Laboratory data recorded included the following: hemoglobin, hematocrit, white blood cell count, electrocardiogram, and chest roentgenogram. Venous pressure, circulation time using ether and/or sodium dehydrocholate (Decholin), and serum CO₂ content were recorded for some patients. Vital capacity of the lungs was recorded preoperatively for every patient. In the early years of this study, it was determined by the resident physician using the hand-held bellows at the bedside. Since 1958, with the establishment of a pulmonary function laboratory, vital capacity and maximum breathing capacity measurements have been done using a two-spirometer machine, the Godart "Pulmoest;" and are expressed as per cent of predicted normal in this paper.

All the charts were studied for the patients' complete clinical course, with particular attention being paid to his pulmonary status. The statistical significance of the data was determined by the Chi square test, using the Yates modification.

RESULTS

Clinical Grouping

The 533 patients comprising this study were divided into six clinical groups, as indicated in Table 1. Groups A, B, and C

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include the 73 patients not tolerating surgery, and groups D, E, and F the 460 who did. These categories were analyzed in detail to see if any significant difference could be found between those who did tolerate surgery, and those who did not.

Cardiopulmonary factors

"Chronic lung disease" was diagnosed in those patients having emphysema, asthma, or chronic cough in addition to pulmonary neoplasm. "Cardiovascular disease" included hypertension, physical or electrocardiographic findings of cardiac abnormalities, and history of myocardial infarction, angina pectoris, cerebrovascular accident, or similar diseases. Tables 2 and 3 indicate no statistically significant differences in ability to withstand surgery when patients were compared in terms of these problems.

Similarly, vital capacity (Fig. 1) was not a significant factor in toleration of surgery, nor was smoking (Table 4).

Maximum breathing capacity (MBC) was determined in 240 patients. Of 33 tested patients not tolerating surgery, seven (21.2 per cent) had an MBC of less than 50 per cent, and of 207 patients tolerating surgery, 55 (26.6 per cent). Even with this great reduction from normal, the MBC was not a differentiating factor.

Table 5 indicates that even multiple cardiopulmonary abnormalities did not significantly influence the results of surgery.

Respiratory Insufficiency

Because of the lack of striking differences when patients were compared on the basis of toleration of surgery, the two most "clinically opposite" groups were studied (Table 6). Most patients in both groups had had a pneumonectomy. Again, statistically significant differences were absent.

Surgical procedures

Table 7 shows the strikingly similar clinical composition of the three categories of surgery performed, and Table 8 the expected finding that with an increased magnitude of surgery and extent of lung tissue removed, there was an increase in the number of patients unable to tolerate the procedure, as well as improved five-year survival.

**DISCUSSION**

It is disappointing, indeed, for the physicians caring for a patient who survives operation for lung cancer, with a good chance for cure, only to have him die during his hospital stay or become a respira-
tory cripple. This study was undertaken in the hope of finding some factor, or constellation of factors, which might be of critical significance in determining which patients would successfully undergo an operative procedure, and which would be better treated by another method. We were especially interested in the role of pulmonary function tests in supplying possible definite criteria for patient selection, despite Comroe's statement that "there is no single test by which all aspects of pulmonary function can be evaluated and no magic number which serves as a sharp dividing line between health and pulmonary disability."

Chronic lung disease, cardiovascular disease, abnormal pulmonary function tests—no one of these factors, nor any combination of them, was found to cause a significant difference in terms of the patient's ability to withstand surgery. Even when extremes of abnormality in vital capacity and maximum breathing capacity were examined, they were found to occur similarly in patients doing well, and those not tolerating operative procedures.

It is possible that more refined pulmonary function tests, such as changes in blood pH and CO₂ content with exercise, may be of greater value in selecting patients for surgery, than the ventilatory tests used in this study.

Perhaps the only positive result of this study is the observation that patients with very poor pulmonary function and evidence of advanced disease can tolerate surgery for their cancer and that these conditions should not in themselves deter the surgeon from making an attempt at cure. Even in our institution there has been a tendency in recent years to put off surgery in these individuals because of the expectation that they would not survive the procedure or would be pulmonary cripples. The data included here would lead to the opinion that most patients, regardless of their associated disease, have a chance of cure if adequate surgery can be performed.

The following two case reports were chosen to document the lack of clinical criteria for the selection of patients for surgery.

<table>
<thead>
<tr>
<th>Table 3—Cardiovascular Disease in 533 Patients Having Thoracic Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Patients Having Surgery No.</td>
</tr>
<tr>
<td>Cardiovascular disease—present</td>
</tr>
<tr>
<td>Cardiovascular disease—absent</td>
</tr>
<tr>
<td>All</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Table 4—History of Smoking and Ability to Tolerate Thoracic Surgery</th>
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<tbody>
<tr>
<td>73 Patients Not Tolerating Surgery No.</td>
</tr>
<tr>
<td>Smoked</td>
</tr>
<tr>
<td>Did not smoke</td>
</tr>
<tr>
<td>Not recorded</td>
</tr>
</tbody>
</table>

**Figure 1:** Distribution of patients according to preoperative vital capacity, expressed as per cent of predicted normal.
Table 5—Preoperative Clinical Evaluation and Postoperative Results

<table>
<thead>
<tr>
<th></th>
<th>CLD(^1) present</th>
<th>CLD absent</th>
<th>CVD(^2) present</th>
<th>CVD absent</th>
<th>Abnormal VC(^3)</th>
<th>Abnormal VC absent</th>
<th>Normal VC</th>
<th>Normal MBC</th>
<th>No other illnesses</th>
<th>present except lung cancer</th>
</tr>
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<tbody>
<tr>
<td>No.</td>
<td>Per Cent</td>
<td>No.</td>
<td>Per Cent</td>
<td>No.</td>
<td>Per Cent</td>
<td>Per Cent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73 patients not tolerating surgery</td>
<td>4</td>
<td>5.5</td>
<td>9</td>
<td>11.9</td>
<td>12</td>
<td>16.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>460 patients tolerating surgery</td>
<td>12</td>
<td>2.6</td>
<td>85</td>
<td>18.5</td>
<td>112</td>
<td>24.3</td>
<td></td>
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</tr>
</tbody>
</table>

\(^1\)CLD means chronic lung disease; \(^2\)CVD means cardiovascular disease; \(^3\)VC means vital capacity; \(^4\)MBC means maximum breathing capacity.

Case 1

F. H., a 60-year-old white man hospital attendant, was admitted to Memorial Hospital June 2, 1955, because of weight loss, non-productive cough, dyspnea, and chest pain progressively severe during the preceding two months. He had smoked a pack of cigarettes daily for 40 years, and stated moderate alcohol consumption. Severe hypertension, with headaches and dizzy spells, had been present for years.

Physical examination of this plethoric man showed the blood pressure to be 200 systolic, 100 diastolic. Pronounced narrowing of retinal arterioles and arteriovenous nicking were noted. There was a lag of the right hemithorax on inspiration, signs of consolidation in the right lung and scattered basilar rales bilaterally. The heart was enlarged. The remainder of the examination was negative.

The hemoglobin was 17.2 gm. per 100 ml., the hematocrit 51 per cent, and the white blood cell count 13,700 per mm.\(^3\) with a normal differential count. The following were normal: urinalysis, fasting blood sugar, serum proteins, alkaline phosphatase, and electrocardiogram. The chest roentgenogram showed atelectasis of the right upper and middle lobes and multiple densities in the right lung. The vital capacity was 2 liters (58 per cent of predicted normal), and the maximum breathing capacity 52.6 liters per minute (54 per cent).

He developed progressive dyspnea and intermittent cyanosis while awaiting surgery, and although he was deemed a "serious operative risk," it was decided the attempt should be made, and on June 14, a right radical pneumonectomy for epidermoid carcinoma was performed without incident. Convalescence was uneventful except for an episode of acute bronchospasm with 27 per cent eosinophilia on June 28, diagnosed as an allergic reaction. The patient remains free of recurrent or metastatic cancer, working until retirement at age 67, with hypertension his chief medical problem at the present time.

Comment: This case report illustrates that a patient with several medical problems and poor pulmonary function may still do well after thoracic surgery. This elderly man had severe hypertensive cardiovascular disease, cyanosis and dyspnea at rest, and greatly diminished vital capacity and maximum breathing capacity, but tolerated well right radical pneumonectomy, and nine years later, is alive and free of respiratory insufficiency and probably cured of his lung cancer.

Case 2

J. L., a 55-year-old Chinese printer, was admitted to Memorial Hospital August 5, 1953,
because of a right lung mass found on chest roentgenogram taken during evaluation of a transiently painful right arm. He had smoked more than two packages of cigarettes daily for 30 years. The review of systems was completely benign, and specifically there were no symptoms of pulmonary or cardiac disease.

The physical examination was entirely normal, as were the following laboratory studies: complete blood count, urinalysis, fasting blood sugar, urea nitrogen, and serum protein. The chest roentgenogram showed a 4 x 3 cm. mass in the right mid-lung field. An electrocardiogram indicated normal sinus rhythm and right bundle branch block. Vital capacity was 2.2 liters (64 per cent of predicted normal) and maximum breathing capacity 98.2 liters per minute (101 per cent).

He was felt to be a good candidate for surgery and on August 7, tolerated well right radical pneumonectomy for epidermoid carcinoma. Convalescence was unremarkable.

He did well until 1956, when progressive pulmonary insufficiency began, documented in 1959 by a vital capacity of 1.08 liters (32 per cent), maximum breathing capacity of 24 liters (31 per cent), and a 39 per cent resting dyspnea index. By 1960, he was declared "obviously a pulmonary cripple," with pronounced shortness of breath on slight exertion, expiratory wheezes in the left lung, a pulse of 100 per minute, respirations 26 to 30 per minute at rest, and a serum CO₂ content of 30 mEq./liter. Tracheal fenestration then resulted in subjective improvement, but in 1961 his serum CO₂ content had risen to 33 mEq./liter. He died January 1, 1964, at home, without further information available.

Comment: This unfortunate man is an example of a patient free of severe complicating illnesses developing respiratory insufficiency after pneumonectomy for lung cancer. At the time of surgery, he had good pulmonary function, and no evidence of lung disease beyond the neoplasm. Although the surgical procedure itself went smoothly, during the ensuing years he developed progressively incapacitating respiratory insufficiency.

Summary

The charts of 533 patients with lung cancer who had had thoracic surgery preceded by pulmonary function tests were reviewed in an attempt to find possible definite criteria indicating whether or not surgery would be tolerated.

Of the 533 patients, 11 died in the operating room or during the first day after surgery, 41 died before leaving the hospital, and 21 (seven living, 14 dead) developed respiratory failure. These 73 patients were considered not to have tolerated surgery.

Thirty-four died of diseases other than pulmonary neoplasm, 50 are living without respiratory insufficiency (nine with cancer,
41 without), and 376 died of lung cancer. These 460 patients tolerated surgery.

Factors considered in preoperative evaluation were chronic pulmonary disease in addition to the neoplasm, cardiovascular disease, associated serious illnesses (such as diabetes, peptic ulcer, alcoholism), vital capacity and maximum breathing capacity. No significant differences could be found among any of the six clinical groups regarding the presence or absence of any of these factors, singly or in combination.

It was concluded that definite clinical criteria had not been found upon which to base the selection of patients for thoracic surgery.

Acknowledgments: The authors gratefully acknowledge the help of Mrs. Charlotte Zweifak, who did the statistical analyses of the data.

We are also indebted to the members of the staff of the Memorial Hospital Thoracic Surgery department, and to all the attending and resident physicians who participated in the care of the patients included in this study.

Resumen

Se estudiaron las historias y documentos de 533 enfermos de cáncer del pulmón a quienes se operó después de hacerles estudios funcionales en un intento de encontrar un criterio claro sobre si la cirugía podría ser tolerada.

De 533 enfermos, 11 murieron en la sala de operaciones o durante el primer día postoperatorio; 41 murieron sin salir del hospital y 21 (7 vivos, 14 muertos) presentaron insuficiencia respiratoria. Estos 73 enfermos se consideraron que no habían tolerado la cirugía. Treinta y cuatro murieron de enfermedades ajenas a la neoplasia pulmonar; 50 vivían con trastorno respiratorio (9 con cáncer, 41 sin él) y 376 murieron de cáncer del pulmón. Estos 460 toleraron la cirugía.

Los factores considerados en la valoración preoperatoria fueron las enfermedades pulmonares además de la neoplasia, enfermedades cardiovasculares, enfermedades graves asociadas (tales como diabetes, úlceras peptico, alcoholismo), capacidad vital y capacidad máxima respiratorias deficientes. No se encontraron diferencias de significación entre ninguno de los seis grupos clínicos respecto de la presencia de cualquiera de estos factores, solos o combinados.

Se concluye que el criterio clínico definido no se encontró sobre el cual se pudiera basar la selección para la cirugía torácica.

Zusammenfassung

Die Krankengeschichten von 533 Patienten mit Lungenkrebs, bei denen eine Thoraxoperation vorgenommen worden war, nach vorausgegangener Lungenfunktionsprüfung wurden durchgesehen mit dem Ziel, möglichst definitive Kriterien zu ermitteln, die darauf hinwiesen, ob der Eingriff vertragen wurde.

Von den 533 Patienten starben 11 im Operationsaal oder während des ersten Tages nach dem Eingriff, 41 starben ohne das Krankenhaus zu verlassen und bei 21 (7 Lebende und 14 Verstorbene) entwickelte sich eine respiratorische Insuffizienz. Von diesen 73 Patienten wurde angenommen, daß sie Eingriff nicht vertragen haben. 34 starben an Krankheiten, die nicht mit dem pulmonalen Neoplasma zusammenhingen, 50 leben ohne respiratorische Insuffizienz (9 mit Krebs, 41 ohne), und 376 starben an Lungenkrebs. Diese 460 Patienten vertrugen die Operation.


Es wurde daraus der Schluß gezogen, daß definitive klinische Kriterien nicht zu ermitteln waren, auf dene die Auswahl der Patienten für die Thoraxoperation hätte begründet werden können.

References


